# The Natural History of Full Thickness Rotator Cuff Tears in Randomised Controlled Trials: A Systematic Review & Meta-Analysis of Operative and Nonoperative Treatments

**Declarations**


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## Abstract

Background: Rotator cuff tears are the commonest tendon injury in the adult population, resulting in substantial morbidity. The optimum management for these patients is not known.

Purpose: To assess the overall treatment response to all interventions in full-thickness rotator cuff tears in patients enrolled in randomised clinical trials.

Study Design: Systematic review and meta-analysis.

Methods: Randomised controlled trials (RCTs) were identified from a systematic search of Medline, Embase and CINAHL databases. Patients aged 18 or over with full-thickness rotator cuff tear. The primary outcome measure was change of Constant shoulder score from baseline at 52 weeks. A meta-analysis to assess treatment response was calculated using the standardised mean change in scores.

Results: We included 57 RCTs. The pooled standardised mean change, compared to baseline was: 1.42 (95% CI 0.80-2.04) at 3 months, 2.73 (95% CI 1.06-4.40) at 6 months and 3.18 (95% CI 1.64-4.71) at 12 months. Graphical plots of treatment response demonstrate a sustained improvement in outcomes in both non-operative trial arms and all operative sub-group arms.

Conclusions: Patients with full-thickness rotator cuff tears demonstrated a consistent pattern of improvement in Constant score with both conservative and operative care. The natural history of patients with rotator cuff tears included in RCTs is to improve over time, whether treated operatively or non-operatively.

What is known about the subject: Rotator cuff tears represent the commonest tendon injury in the adult population, however the optimum management of these patients is not known. In other chronic musculoskeletal conditions, it has been shown that there is improvement in clinical outcome measures with all treatments over time. However, it is not known if this is also true for rotator cuff tears.

What this study adds to existing knowledge: This review found there is consistent improvement in Constant score, irrespective of intervention given whether it is operative, or non-operative treatments. Patient outcomes at 12 months are highly predictive of outcomes at 24 months, suggesting that 12-month should be used as a primary outcome time point for future randomised controlled trials in full-thickness rotator cuff tears.

## MAIN TEXT

### Introduction

Rotator cuff tears are the commonest tendon injury in the adult population, affecting approximately 30% of the population above the age of 60 [82]. The prevalence increases with age. Risk factors for development include male gender, employment consisting of manual labour and previous trauma [96]. Whilst many tears are asymptomatic, up to 35% of patients will then progress to develop pain and inability to perform activities of daily living [70,95]. For patients with full-thickness rotator cuff tears there is debate about the optimum management, including the use of different operative techniques, operative adjuncts, and non-operative management [25,56]. Nevertheless, there has been a trend to provide more surgical treatments for these injuries. The number of rotator cuff repairs performed in the UK increased by 238% over 14 years to 2009 [27].

Over recent years there has been a substantial growth in the number of randomised controlled trials and systematic reviews of shoulder treatments [38,40,41,66]. However, most studies show, at best, a modest additional improvement in patient reported outcomes over time, with no clear superiority of one treatment modality over the other [38,40,41,66].

In other chronic, painful conditions, it has been noted that outcomes improve over time in patients in randomised trials, regardless of their treatment [3,4,90]. This may be due to the natural history of chronic musculoskeletal conditions, regression to the mean or other unrecognised mechanisms. As a result, it presents a challenge for the interpretation of outcomes in studies of patients with rotator cuff tears. Randomised trials are a good source of information on the natural history of a condition because

they have well defined entry criteria, are prospective by definition, and typically have well defined follow-up time points. In addition, the natural history of patients with rotator cuff pathologies in randomised controlled trials needs to be better understood to improve the planning and conduct of further trials in this area.

**Aims:** To assess the outcomes and trajectories over time amongst patients with full-thickness rotator cuff tears in randomised clinical trials.

## Methods

This study was reported in accordance with the PRISMA statement for reporting systematic reviews. The systematic review protocol was pre-defined and can be found at http://www.crd.york.ac.uk/PROSPERO (CRD42016047715).

*Inclusion Criteria*

Inclusion criteria were: (i) full text, randomised controlled trials in English language, (ii) any humans of any age with isolated full thickness rotator cuff tears, (iii) studies comparing both operative and non-operative interventions and (iv) reporting clinical outcome measures chosen for this review were included.

*Exclusion Criteria*

Exclusion criteria were: (i) non-randomised studies, (ii) studies reporting biomechanical and radiological outcomes, (iii) studies not reporting clinical outcomes selected for this review and (iv) abstract publication only.

Studies including patients with partial-thickness tears or examining treatments for shoulder disorders other than full-thickness tears were also excluded.

Up to three attempts were made to contact the corresponding author for additional information if; (i) further information was required about study design to confirm inclusion, (ii) there were missing data for unreported or partially unreported outcomes or (iii) outcomes were for the full-thickness sub-population where the study population was mixed (full thickness and other pathologies).

*Outcome measures*

The primary outcome measure was the Constant shoulder score [20] at 52 weeks. The Constant score is the most widely used shoulder evaluation score in Europe [51] and has been described as the most efficient outcome measure for patients with rotator cuff tears [61]. It is a composite core measuring a combination of physical examination and subjective assessments from the patient.

The secondary outcome measures included: (i) the American Shoulder and Elbow Score (ASES) [83] at all time points, (ii) the University California-Los Angeles (UCLA) [2] score at all time points, (iii) the Disabilities of the Arm, Shoulder and Hand (DASH) [39] and (iv) Constant score (including modifications of the Constant score) [20] at all time points.

*Search Strategy and quality assessment*

We searched Medline, Embase, The Cochrane central register of controlled trials and CINAHL databases from inception to 14th September 2016 and imported citations into EndNote X7 (New York, USA) reference management software. A full search strategy can be found in the supplementary material. Following removal of duplicates, citations were screened using title and abstract with the inclusion criteria described above applied. To reduce the risk of publication bias, if multiple studies reported the same, or an overlapping population, only the study with the longest follow up was included. For those studies that potentially met eligibility criteria, full texts were obtained. Two authors (CK & IA) independently assessed each paper, with any discrepancies being resolved with discussion with the senior authors (NS & AM).

We did a qualitative risk of bias assessment using Cochrane guidelines [37]. Where the main paper did not include sufficient information to complete risk of bias assessment any published protocols were also examined.

*Statistical analysis*

We extracted outcome data from each study according to follow up time period. As there was often a wide heterogeneity in follow up time points, the exact time point was recorded, even if different for study arms. As performed in a similar meta-analysis by Artus et al. [3], we developed a data analysis plan, including a descriptive analysis, assessment of the variation of size of response and finally the overall pattern of response prior to data extraction.

*Extracting data*

We extracted the number of patients in each arm, the intervention type for each arm, which was defined as repair, acromioplasty alone or conservative. In addition, the mean and standard deviation (SD) of Constant score (standard and modified), gender, dominant hand and the time point assessed were extracted for each study. If a study did not report one of these statistics, then estimates of missing values were calculated from other reported values, such as the test statistic or p-value using standard methods as described in the Cochrane Handbook [34]. Where data in studies was not represented in numerical format, data were extracted from graphs by two authors (CK & IA) to improve accuracy of data.

*Assessing the general response of treatment*

Outcome scores were graphically plotted against time using Microsoft Excel (Microsoft Excel for Mac 2011, Washington, USA) to describe change from baseline to all follow up points reported in all treatment arms from included studies. Data were explored visually for a descriptive analysis of response. As a visual response trend was required, studies using modified versions of Constant score were included.

*Assessing variation of size of response*

To determine variation in size of response we analysed the change in outcome score by calculating the bias-corrected standardised mean change (SMC) at three, six, 12 and 24 months). This technique is used frequently when studies report efficacy in terms of a continuous measurement. For example, it could be used when comparing the outcome of a new analgesic drug using visual analogue pain scales as an outcome, comparing intervention and placebo. The SMC could be interpreted as the 'standardised' measure of outcome, where (assuming high scores denote more severe pain) if there were no difference between the interventions, the SMC would be zero, whilst a negative SMC would represent a reduction in pain. The SMC score is calculated by subtracting the follow up mean score in chosen outcome measure from the baseline mean score. This is then divided by its pooled SD, multiplied by a bias correction factor based on the group size [71]. If the pooled SD was not reported, the baseline SD was used, or the SD at follow up. Estimates of the variance of the SMC were also calculated [72] and used to construct 95% confidence intervals. To allow for the repeated measures design, the within-group correlation was set at 0.5 for all studies [17].

*Summarising the overall response to treatment*

As the SMC standardises the measurement of change over time, studies using slightly different scales can be pooled together for comparison. As such, studies using modified or adjusted Constant scores were combined alongside those that reported unmodified scales. As for similar meta-analyses [3], one arm was then randomly selected per trial. This was because changes in outcome over time were of interest, rather than between arms comparison (e.g. to demonstrate superiority of one type of intervention). Intervention arms from each study are likely to be further correlated since participants recruited to each trial are likely to have similar characteristics and therefore have a similar response to treatment, which means that observations from different study arms would not be independent. Furthermore, the objective of this review was to describe the effect of treatments and not to estimate effect sizes between intervention groups.

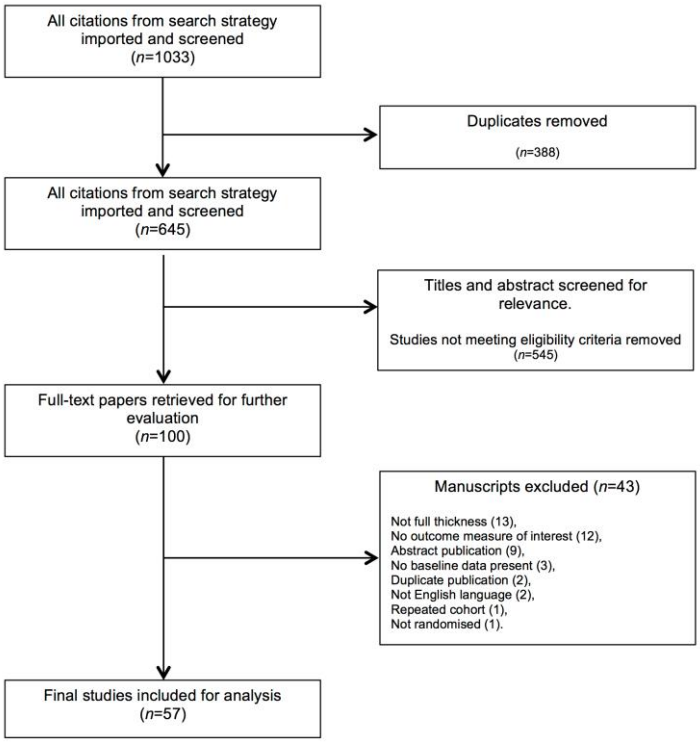
We calculated a combined pooled estimate of SMC for each time point using a random effects model. Studies were subcategorised according to treatment given to: (i) where primary repair was performed (ii) where acromioplasty was performed only iii) conservative (non-operative) treatment. If patients had a primary repair and another treatment adjunct was applied (such as the application of platelet rich protein or acromioplasty) the study arm was allocated to repair group. We did a simple correlation analysis (using Pearson's correlation coefficient) on the SMCs between each time point to assess the relationship between each subsequent time point.

Analyses were conducted in R (Vienna, Austria) [80] and using the metafor package [92].

## Results

A total of 1033 citations were received from our search strategy. After removal of duplicates and screening of studies by title and abstract, 100 full text papers were retrieved. Out of these, 57 studies met our inclusion criteria from which 43 studies used the Constant score as an outcome measure (Figure 1). Of the 57 studies selected, 14 study authors were contacted for further information, however no responses were received.

**Figure 1**: Flow diagram detailing inclusion of studies into the review.




*Description of studies included*

With respect to studies reporting the Constant score; there were 39 studies with 73 arms that described treatment response for operative interventions of which eight studies with eight arms had repair and acromioplasty performed; two studies with two arms for acromioplasty only; five studies with seven arms were described for non-operative interventions. 26 studies with 53 arms reported the ASES score; 20 studies

with 40 treatment arms reported the UCLA score. The DASH was the least frequently reported score, with seven studies reporting 14 different treatment arms. A description of included studies is available in Table 1.

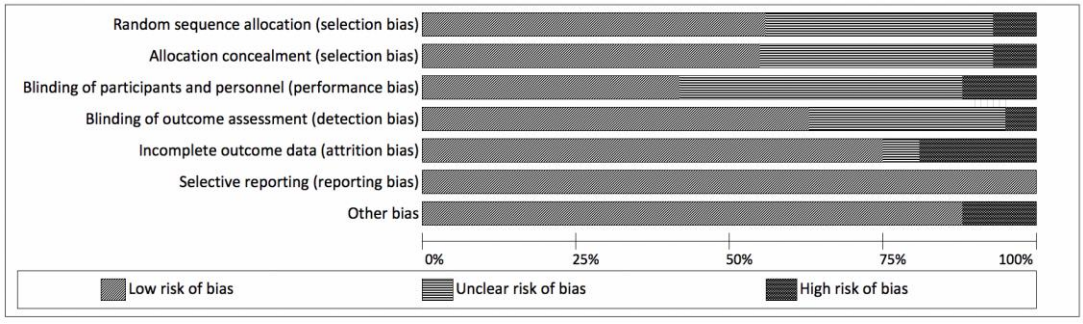
*Description of patient population included*

We included data from 4542 participants in this review, with study populations ranging from a minimum of 20 to 248 patients. Within the included studies, eight did not report gender. Of those that did report gender of patients included, 48% of participants were male. Four studies out of 57 did not report age; in those that did, the median of the mean reported age of participants was 59.0 (IQR 5.3). Of those studies included, 27 did not report dominant hand of included patients. From those studies reporting, 71% of participants had a full-thickness tear of their dominant side.

*Risk of bias assessment*

Studies included in this review had a low risk of bias for all domains apart from blinding of participants and personal (performance bias); 42% (24/57) of studies had a low risk of performance bias: 47% (27/57) of studies had an unclear risk of bias (Figure 2).

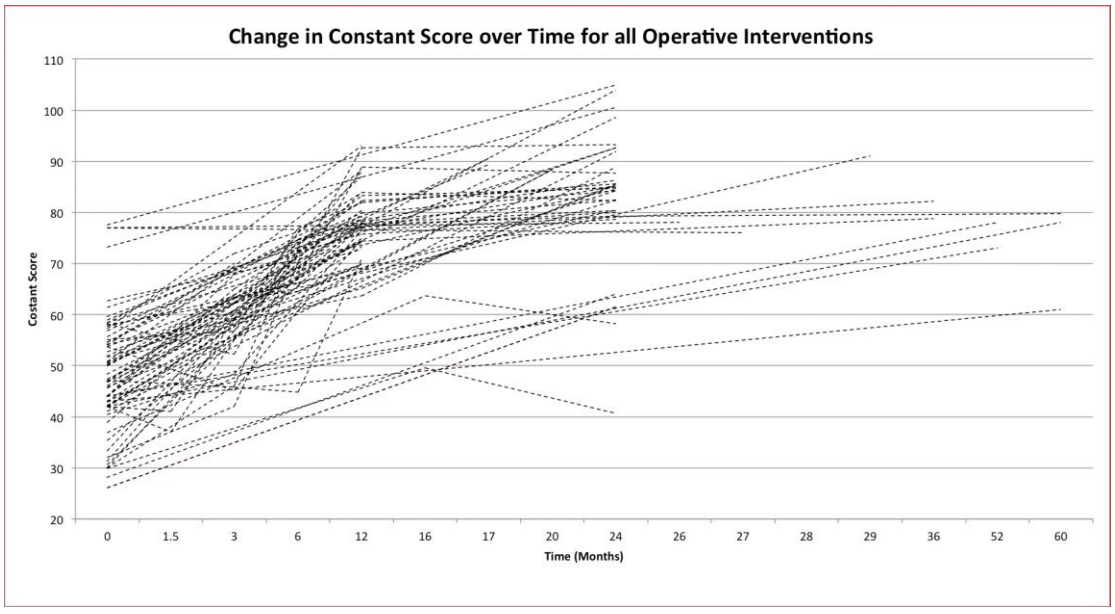
**Figure 2:** Summary Table of Risk of Bias Assessment for Studies Included

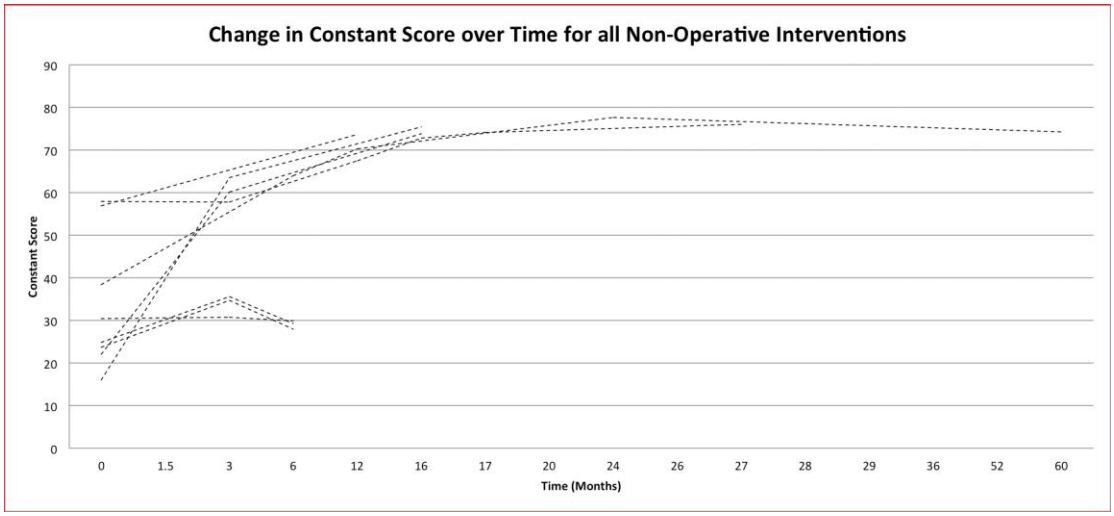



*The general response to treatment*

There was an overall improvement in all arms from baseline for studies reporting Constant score (Figure 3). When exploring differences between operative and non-operative arms, this effect was sustained, with all study arms showing positive change. Treatment response in all outcome measures (ASES, UCLA and DASH) showed an improvement in functional outcomes regardless of treatment intervention applied (Figure 4). Studies that followed up patients at multiple time points indicate an improvement in outcome in the first 12 months, following which the rate of improvement stabilised. This pattern was consistent irrespective of treatment type given (primary repair, acromioplasty only, or non-operative intervention).

**Figure 3:** Change in Constant score for all operative and non-operative interventions over time (includes modified Constant score)






306
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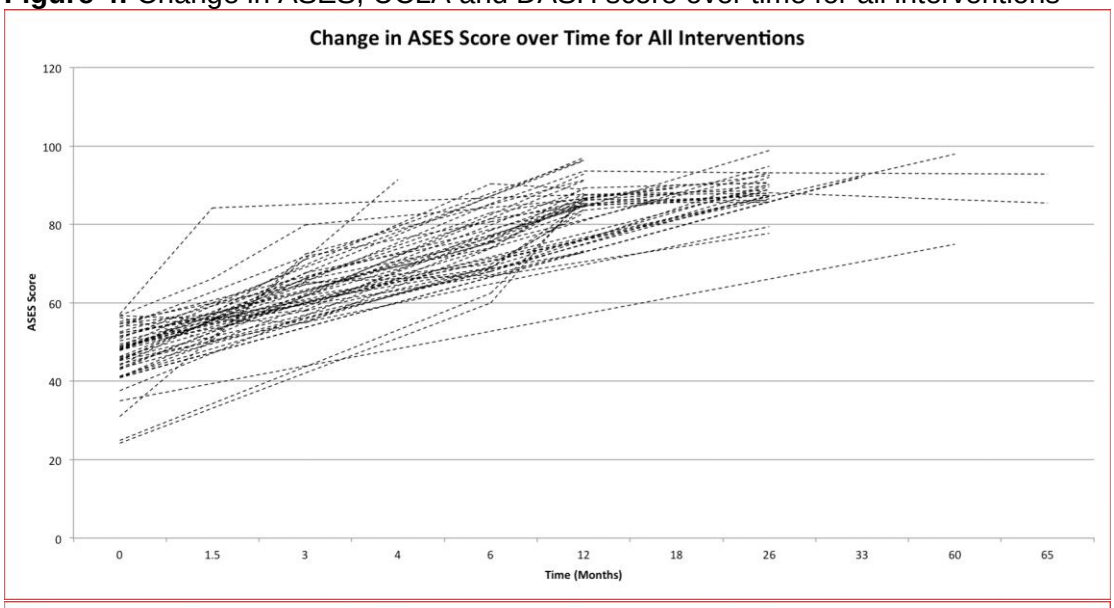
308 **Figure 4:** Change in ASES, UCLA and DASH score over time for all interventions

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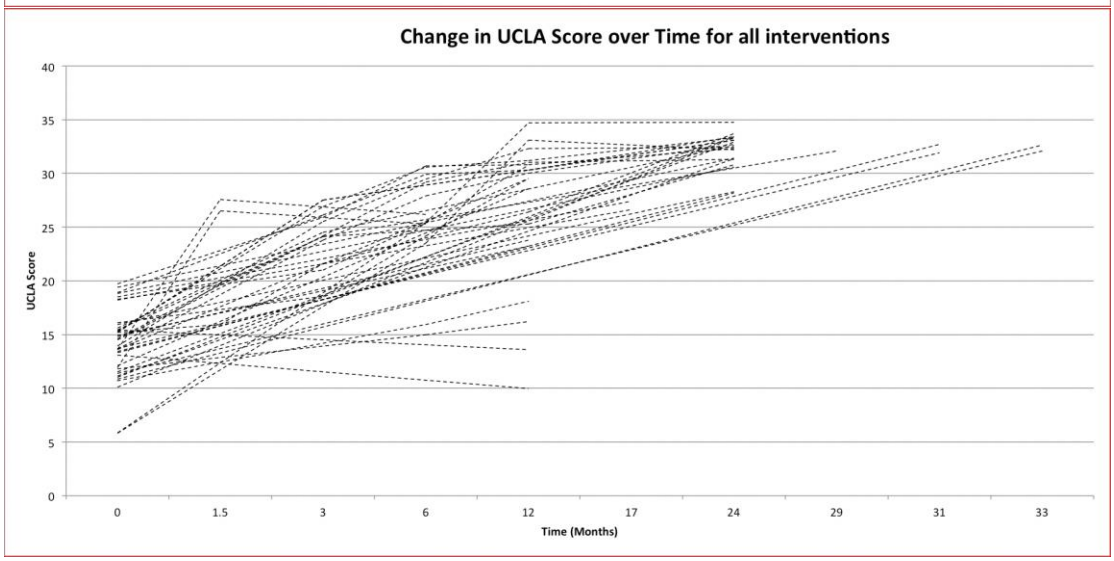


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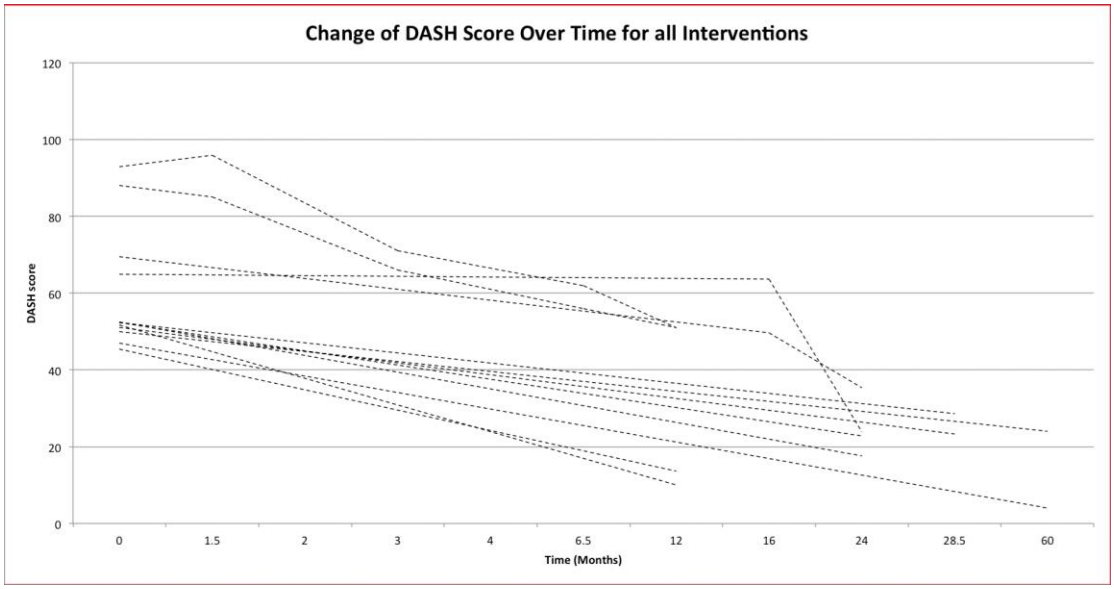


*Summary of responses to treatments*

A forest plot describing the pooled SMC from baseline for all sampled treatment arms was produced for the Constant Score (Figure 5). This showed a large pooled treatment response at 3 months (1.42 [95% CI 0.80-2.04]) and at 6 months (2.73 [95% CI 1.06-4.40]). The largest change was seen at 12 months (3.18 [95% CI 1.64-4.71], which then reduced slightly at 24 months (2.98 [95% CI 1.40-4.55]).

**Figure 5:** SMC for Constant score for one arm randomly selected from each trial arm at 3, 6, 12 and 24 months.

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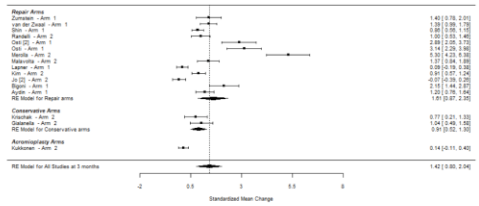

**Figure 5a:** Constant Score at 3 months

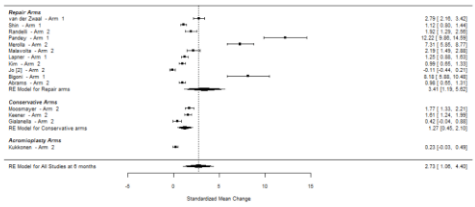

**Figure 5b:** Constant Score at 6 months

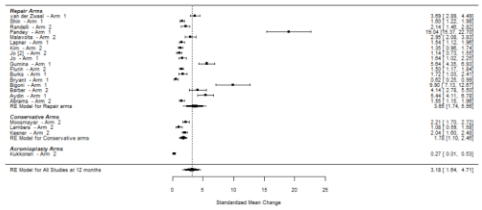

**Figure 5c:** Constant Score at 12 months

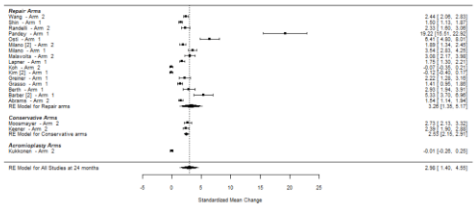

**Figure 5d:** Constant Score at 24 months

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323 In the sub-group analysis, the greatest effects were seen in patients undergoing
324 rotator cuff repair, although a meta-analysis of papers directly comparing the two was
325 not performed and therefore this should not be taken as direct evidence of benefit for
326 repair. Trends in the effects followed the same pattern as observed in the main
327 analysis, with the largest effects observed at 12 months with a SMC of 3.65 (95% CI
328 1.74-5.56) for patients undergoing repair compared to 1.78 (95% CI 1.10-2.46) for
329 conservative and 0.27 (95% CI 0.01-0.53) for acromioplasty patients.

330

331 There was strong correlation in SMCs for each time point, which increased as the
332 studies progressed. The Pearson's correlation coefficients were 0.816 (n=11, 95% CI
333 0.424 to 0.951) between 3 months and 6 months, 0.987 (n=13, 95% CI 0.957 to
334 0.996) between 6 months and 12 months and 0.999 (n=9, 95% CI 0.996 to 1.00)
335 between 12 months and 24 months.

336

## Discussion

We aimed to collate the evidence on the short-term natural history of patients with symptomatic full-thickness rotator cuff tears, regardless of the treatment they received. The studies included in this review examined a wide variety of treatment modalities, including a variety of operative techniques as well as non-operative interventions. This review found that treatment response follows a similar pattern of rapid improvement in the first 12 months after an intervention, after which the recovery plateaus. This pattern was found in all treatment arms irrespective of intervention applied, including either surgical or non-surgical care.

Whilst assessing the natural history of a condition using randomised trial data alone may seem counter-intuitive, there are a number of good reasons for doing so. Randomised trials typically have well organised follow-up arrangements at fixed time periods from randomisation, which are usually pre-defined. By definition, they are prospective studies in well-defined populations. A well-constructed cohort study can achieve all of these things but this is harder to detect and assess when reviewing a paper, and many cohort studies suffer from being conducted with cross-sectional sampling, meaning that follow-up times vary considerably from the intervention. This may be valuable in a long-term follow up study, but the purpose of this study was to examine short to medium-term outcomes (that is, in the first few months and years after the intervention) and as such, randomised trials provide a wealth of prospective data with fixed time points for follow up.

In determining an explanation for the patterns that were observed, consideration must be given to the natural history of rotator cuff tears. Previously conducted systematic reviews have commented on the scarcity of studies investigating the topic [26]. A cohort study by Safran and colleagues assessing the natural history in

symptomatic, full-thickness rotator cuff tears who were treated non-operatively found that patients often had progression in tear size which was linked to a deterioration in pain [86]. This is different to our findings, where we found non-operatively treated patients improve in outcome measures. In the above study, it is not explained why their cohort was treated non-operatively, as perhaps these patients may have been unsuitable for operative intervention. On comparison, in half of the studies included in this review with a non-operative arm, participants would have been suitable for an operative intervention. In addition, people included in studies with only non-operative arms may not have had significant disability to seek operative intervention. As such this may represent two different sub-sections of the population.

Moosmayer found that patients with asymptomatic rotator cuff tears often progressed to become symptomatic, representing a structural deterioration of the rotator cuff [70]. However, this patient cohort differs from those entered into randomised controlled trials, as asymptomatic patients are unlikely to actively seek healthcare. In contrast, patients seeking surgical treatment are likely to represent a sub-section of the population with the worst symptoms, leading to lower baseline outcome scores. As such, these patients also represent those who have the potential for larger reductions in symptoms and therefore the greatest treatment response.

The phenomenon of regression to the mean is a ubiquitous statistical occurrence in repeated data. This suggests that if a variable is extreme on its first measurement, it will tend to be closer to the population mean on subsequent measurements [73]. In other words, if a patient's pain varies, they will typically see a specialist and be entered for treatment (or into a study) when the pain is at its peak, and in future measurements it will be reduced as the pain then falls from that previous peak. As such, patients with worse baseline outcome measures represent those with greater potential to improve due to regression to the mean. Equally, it may be that patients

who present with pain and symptoms will recover with time and patient care, as implied by these studies where there is a large effect and regression to the mean may seem to be unlikely. In reality, it is difficult to separate the effects of regression to the mean from the true natural history of full-thickness tears.

Thought must also be given to non-specific factors for change in outcomes. Indeed, there is evidence to suggest participation in randomised controlled trials may itself confer benefit to patients [13]. This effect is particularly seen in situations where effective treatments are included in the trial protocol [13], such as for many studies included in this review. Other factors, such as trust in health care professional delivering treatment [10] and the manner in which patients expectations for treatment response is enhanced by positive information [11] all significantly contribute to the improvement of health outcomes. In addition, attributes from the patient including their expectation, emotions and psychological conditioning have been found to be of positive influence [52,79]. Perhaps the best recognised is the role of the placebo in influencing outcomes. Whilst its influence within drug trials is well established, there is evidence for its use as an effective treatment in other chronic musculoskeletal conditions [97]. Furthermore, the placebo can be augmented with previously mentioned factors such as clinician warmth [45]. Again it is difficult to estimate the effect of these factors into the trials included in this study.

One other consideration is the timing of outcomes in randomised studies. It is common for reviewers to insist on 24-month outcomes, however we found that they add little value beyond 12 months. After 12 months in all treatment arms, the improvement stabilised, and correlations in scores at different time points were very high. In other words, once the 12-month outcomes were known then the 24-month outcomes were highly predictable. We recommend a 12-month primary outcome based on our findings. This has important implications in the delivery of randomised

trials, which are often expensive and time consuming, and reporting at 12 rather then 24 months would save substantial cost as well as time in producing an answer that can be delivered to improved clinical care for patients, whereas waiting for a 24 month follow-up adds little. This is not to say that later follow-up (say, five or ten year) does not add different or valuable information, but in terms of short to medium-term outcomes, a primary outcome at 12 months can be recommended based on our findings.

Surgical treatments may be effective, although their true effect over non-operative treatment is likely to be much less than the effect that seen in uncontrolled case-series. Our data show that such an improvement may also be seen with conservative treatments. The overall effect of surgery can only be assessed by comparing surgery to conservative treatment, and consideration should also be given sham or placebo controlled trials of surgery [31,94]. When assessing the results of surgical procedures, and surgeons should be aware of the natural history of symptomatic cuff tears in the short term to improve substantially with conservative care alone when they assess the result of other treatments or procedures.

*Strengths and Limitations*

This study was conducted and reported in accordance with the PRISMA guidelines [67]. It was conducted with a pre-defined and published study protocol.

We used the Constant score as its primary outcome measure. It is the most widely used assessment tool [51] and was the most frequently outcome measure in studies included in this review thus giving the greatest volume of data to pool. Other measures used in this review including ASES, UCLA score and the DASH score were next commonly reported and thus represented an appropriate secondary

outcome measures. A small number of trials used other measures such as change in visual analogue score, or purely radiological outcome measures, which were therefore not included. As these were so infrequently reported and varied in their definitions, any meaningful pooling of this data would not have been possible.

Only trials with fully published outcome measures were included. Thus, there is a risk of publication bias from studies with incomplete outcome data, which were excluded from the study analysis. In line with Cochrane guidelines, authors of the papers were contacted with reasonable efforts in order to minimise this. A further limitation is that only English language studies were included. However, this results in only two studies being excluded and those that were included were from a wide distribution geographically. The large number of included studies showing consistent results suggests is unlikely that our conclusions would be changed if any other such studies had been included.

This study has not been designed as a meta-analysis to directly compare rotator cuff repair, acromioplasty or physiotherapy, and rather is a description of the natural history of each treatment. Conclusions on the relative merits of the treatments should not be directly inferred from these findings. Different studies are included which may have had different populations in them. An example of this is the apparent worse performance of acromioplasty relative to repair or conservative care. Whilst the study did adjust for baseline scores, the different studies are not necessarily the same population of patients or types of tear, so care should be taken in over-interpreting our findings. However, it makes an important statement about the likely outcome of patients with symptomatic cuff tears over time, and this needs to be considered when interventions such as surgery are being considered, or when other treatments are being evaluated.

We did not assess the long-term outcomes of these patients. Certainly, it is established that massive rotator cuff tears can lead to the development of rotator cuff arthropathy [24]. This may then result in a deterioration of outcomes and there is evidence to suggest early repair of rotator cuff tears can prevent progression into rotator cuff arthropathy [19,74]. Unfortunately long term outcomes were beyond the scope of this review as it was based on trial data, which typically does not extend long enough to assess long-term outcomes.

## Conclusions

We have shown that patients with symptomatic full-thickness rotator cuff tears demonstrate a consistent and considerable response to treatment, even with conservative management. The largest improvement occurs in the first 12 months, after which the response stabilises. When assessing the treatment effect of invasive surgery, consideration must be given to the natural history of patients with rotator cuff tears to improve over time with non-operative care as well.

## Funding

There was no funding allocated for this systematic review.

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**Table 1:** Study Characteristics

| Author | Year published | Comparison | Participants *(n)* | Male *(n)* | Female *(n)* | Age | Dominant side *(n)* | Non dominant side *(n)* |
|---|---|---|---|---|---|---|---|---|
| **Abrams *et al.*** [1] | 2014 | Repair *vs*. Repair & Acromioplasty | 114 | 64 (56.1%) | 50 (43.9%) | 58.8 | | |
| **Aydin *et al.*** [5] | 2010 | Single *vs.* Double Row Repair | 68 | | | 58.0 | | |
| **Barber *et al.*** [91] | 2016 | Single *vs*. Double Row Repair | 40 | 24 (60.0%) | 16 (40.0%) | 56.0 | 33 | 7 |
| **Barber *et al.*** [6] | 2012 | Repair *vs*. Repair & Human Dermal Matrix | 42 | 31 (73.8%) | 11 (26.2%) | 56.0 | | |
| **Berth *et al.*** [7] | 2010 | Partial Repair *vs*. Debridement & Acromioplasty | 42 | 31 (73.8%) | 11 (26.2%) | 63.4 | 29 | 13 |
| **Bidwai *et al.*** [8] | 2016 | Mini-Open Repair *vs*. Acromioplasty | 33 | 26 (78.8%) | 7 (21.1%) | 67.7 | | |
| **Bigoni *et al.*** [9] | 2009 | Side-to-Side Repair *vs*. Tendon–to–Bone Fixation | 50 | | | 59.0 | | |
| **Boehm *et al.*** [12] | 2005 | Mason-Allen Suture *vs*. Kessler Suture | 100 | 68 (68.0%) | 32 (32.0%) | 56.5 | | |
| **Bryant *et al.*** [14] | 2016 | Repair & Porcine Small Intestine Mucosa *vs*. Repair | 62 | 51 (81.3%) | 11 (17.7%) | 56.6 | | |
| **Burks *et al.*** [15] | 2009 | Single *vs*. Double Row Repair | 40 | | | 56.5 | | |
| **Carbonel *et al.*** [16] | 2012 | Single *vs*. Double Row Repair | 160 | 68 (43.5%) | 92 (57.5%) | 55.5 | | |
| **Castricini *et*** | 2011 | Repair & Platelet Rich Plasma | 88 | 40 | 48 | 55.3 | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| ***al.*** [18] | | *vs*. Repair | | (45.5%) | (55.5%) | | | |
| **Cuff *et al.*** [21] | 2012 | Early Physiotherapy *vs*. Late Physiotherapy | 68 | 38 (55.9%) | 30 (44.1%) | 63.2 | | |
| **Dezaly *et al.*** [22] | 2011 | Repair & Acromioplasty *vs*. Acromioplasty | 127 | 58 (45.7%) | 69 (54.3%) | 67.8 | | |
| **Duzgun *et al.*** [23] | 2011 | Early Rehabilitation *vs*. Late Rehabilitation | 29 | 3 (10.3%) | 26 (89.7%) | 56.3 | | |
| **Flurin *et al.*** [28] | 2013 | Repair *vs*. Repair & Acromioplasty | 154 | 60 (39.0%) | 94 (61.0%) | 74.3 | | |
| **Franceschi *et al.*** [29] | 2007 | Single *vs*. Double Row Repair | 60 | | | | | |
| **Gartsman *et al.*** [30] | 2004 | Repair & Acromioplasty *vs*. Repair | 93 | 42 (45.2%) | 51 (55.8%) | 59.7 | | |
| **Gialanella *et al.*** [32] | 2011 | Steroid Injection *vs*. Steroid injection *vs*. No Treatment (Control) | 60 | 5 (8.3%) | 55 (91.7%) | 78.7 | | |
| **Grasso *et al.*** [33] | 2009 | Single *vs*. Double Row Repair | 80 | 34 (42.5%) | 46 (57.5%) | 56.8 | 56 | 24 |
| **Greiner *et al.*** [35] | 2015 | Lateralised Reverse Shoulder Arthroplasty *vs*. Reverse Shoulder Arthroplasty | 34 | 12 (35.3%) | 22 (64.7%) | 75.4 | | |
| **Gumina *et al.*** [36] | 2012 | Repair & Platelet/Leucocyte Membrane *vs*. Single Row Repair | 80 | 41 (51.3%) | 39 (48.8%) | 61.0 | 58 | 22 |
| **Jacquot *et al.*** [42] | 2014 | Arthroplasty & Tenotomy vs. Arthroplasty, Tenotomy & Tendon Suture | 103 | 50 (48.5%) | 53 (51.5%) | 68.0 | 75 | 28 |
| **Jo *et al.*** [43] | 2013 | Repair & Platelet Rich Plasma | 48 | 24 | 24 | 63.1 | 42 | 6 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | *vs*. Repair | | (50.0%) | (50.0%) | | | |
| **Jo *et al.*** [44] | 2015 | Repair & Platelet Rich Plasma *vs*. Repair | 74 | 17 (30.0%) | 57 (77.0%) | 60.4 | 57 | 17 |
| **Keener *et al.*** [46] | 2014 | Repair & Traditional Rehabilitation vs. Repair & Immobilisation | 124 | | | | | |
| **Kim *et al.*** [47] | 2011 | Distal Clavicle Resection *vs*. Repair | 83 | 40 (48.5%) | 43 (42.5%) | 56.9 | | |
| **Kim *et al.*** [48] | 2012 | Repair & Extracorporeal Shockwave Therapy *vs*. Repair | 71 | 32 (45.1%) | 39 (54.9%) | 59.0 | 40 | 31 |
| **Kim *et al.*** [49] | 2012 | Early Passive Motion *vs*. Immobilisation | 105 | 44 (41.9%) | 61 (58.1%) | 60.0 | 69 | 36 |
| **Kim *et al.*** [50] | 2016 | En Masse Repair *vs*. Double Layer Repair | 82 | 27 (32.9%) | 55 (67.0%) | 65.3 | | |
| **Ko *et al.*** [87] | 2008 | Modified Mattress Suture *vs*. Simple Stitch | 78 | | | 53.2 | | |
| **Koh *et al.*** [53] | 2014 | Repair & Four Weeks Immobilisation *vs*. Repair & Eight Weeks Immobilisation | 100 | | | | | |
| **Krischak *et al.*** [54] | 2013 | Occupational Therapy *vs*. Home Based Therapy | 38 | 24 (63.2%) | 14 (36.8%) | 55.0 | 24 | 14 |
| **Kukkonen *et al.*** [55] | 2015 | Physiotherapy *vs*. Acromioplasty & Physiotherapy *vs.* Repair, Acromioplasty & Physiotherapy | 167 | 80 (47.9%) | 87 (52.1%) | 65.0 | 111 | 56 |
| **Lambers *et al.*** [57] | 2015 | Repair *vs*. Physiotherapy | 56 | 35 (62.5%) | 21 (37.5%) | 60.6 | 46 | 10 |
| **Lapner *et al.*** | 2012 | Single *vs*. Double Row Repair | 90 | 64 | 26 | 56.8 | 66 | 24 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| [58] | | | | (71.1%) | (28.9%) | | | |
| **Ma *et al.*** [59] | 2012 | Single *vs*. Double Row Repair | 53 | 29 (54.7%) | 24 (45.3%) | 61.2 | 34 | 19 |
| **MacDonald *et al.*** [60] | 2011 | Repair *vs.* Repair & Acromioplasty | 86 | 56 (65.1%) | 30 (34.9%) | 56.8 | | |
| **Malavolta *et al.*** [62] | 2014 | Repair & Platelet Rich Plasma *vs*. Repair | 54 | 17 (31.5%) | 37 (68.5%) | 54.6 | 42 | 12 |
| **Merolla *et al.*** [63] | 2015 | Repair & Tendisulfar *vs*. Repair | 100 | 55 (55.0%) | 45 (45.0%) | 54.3 | 82 | 18 |
| **Milano *et al.*** [64] | 2010 | Metal Anchors *vs*. Biodegradable Anchors | 110 | 66 (60.0%) | 44 (40.0%) | 61.6 | 70 | 40 |
| **Milano *et al.*** [65] | 2013 | Repair & Microfracture *vs*. Repair | 73 | 41 (51.2%) | 32 (43.8%) | 61.8 | 54 | 19 |
| **Mohtadi *et al.*** [68] | 2008 | Mini-open Repair *vs*. Open Repair | 63 | 42 (66.7%) | 21 (33.3%) | 56.6 | 55 | 8 |
| **Moosmayer *et al.*** [69] | 2014 | Repair *vs*. Physiotherapy | 103 | 73 (70.9%) | 30 (29.1%) | 60.0 | 64 | 39 |
| **Osti *et al.*** [76] | 2015 | Repair & Electromagnetic Fields *vs*. Repair | 66 | | | 62.0 | | |
| **Osti *et al.*** [75] | 2013 | Repair & Microfracture *vs*. Repair | 57 | | | | | |
| **Pandey *et al.*** [78] | 2016 | Repair & Platelet Rich Plasma *vs*. Repair | 102 | 74 (72.5%) | 28 (27.5%) | 54.0 | 65 | 37 |
| **Randelli *et al.*** [81] | 2013 | Repair & Platelet Rich Plasma *vs*. Repair | 53 | 21 (39.6%) | 32 (43.8%) | 60.0 | 41 | 12 |
| **Rodeo *et al.*** [84] | 2012 | Repair & Platelet Rich Plasma *vs*. Repair | 79 | 44 (55.7%) | 35 (44.3%) | 58.0 | | |
| **Ruiz-Moneo** | 2013 | Repair & Platelet Related | 69 | 25 | 44 | 55.5 | | |

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|---|---|---|---|---|---|---|---|---|
| ***et al.*** [85] | | Growth Factor *vs*. Repair | | (36.2%) | (63.8%) | | | |
| **Shibata *et al.*** [88] | 2001 | Sodium Hyaluronate Injection *vs*. Steroid Injection | 78 | 55 (70.5%) | 23 (29.5%) | 61.5 | 50 | 28 |
| **Shin *et al.*** [89] | 2012 | Repair & Acromioplasty *vs*. Repair | 120 | 67 (55.8%) | 53 (44.2%) | 56.8 | 87 | 33 |
| **van der Zwaal *et al.*** [77] | 2013 | Arthroscopic Repair *vs.* Mini – Open Repair | 95 | 57 (60.0%) | 38 (40.0%) | 57.6 | 72 | 23 |
| **Wang *et al.*** [93] | 2015 | Single *vs*. Double Row Repair | 248 | 67 (27.0%) | 95 (38.3%) | 58.0 | 79 | 88 |
| **Zhang *et al.*** [98] | 2014 | Mini-Open Repair *vs.* Arthroscopic Repair | 108 | 55 (50.9%) | 53 (49.0%) | 54.1 | 84 | 24 |
| **Zumstein *et al.*** [99] | 2015 | Repair & Platelet Rich Plasma *vs*. Repair | 20 | 10 (50.0%) | 10 (50.0%) | 63.9 | 18 | 2 |